Nestlé Nutrition Institute

New trends in enteral nutrition for children with **gastrointestinal impairment**

There have been major advances in enteral nutrition (EN) in recent decades. Children with paediatric chronic disease now have improved prognosis, extended life expectancy and can enjoy a more normal lifestyle.

Beyond standard milk-based formula, blenderised real food has become increasingly popular among parents and caregivers of patients. Enteral formula manufacturers have responded by developing real-food formulas that are well tolerated and may improve patient gastrointestinal symptoms. Long-term EN is now a viable option for patients, but we should also ask how patients can be weaned from it and resume a real-food diet.

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Weaning from enteral nutrition: who, when and how

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Weaning from EN can be a challenge for parents and healthcare providers and approaches to weaning varies widely worldwide, but it is possible.

Who can be weaned from EN?

A study of 368 children receiving long-term percutaneous endoscopic gastrostomy (PEG) found that feeding weaning was possible in 27% of neurologically impaired (NI) children.[1] This is significant because previously, all these patients would have had life-long dependency on EN. Weaning was possible for 69% of non-NI patients.[1]

Initiating weaning earlier in life is associated with higher chances of success, but duration of EN does not appear to be a factor. Sustained weaning is achieved in 70-80% of patients.[2]

A review looked at the criteria applied by caregivers for selecting patients for weaning from EN. Key criteria were normal nutritional status (98% of respondents applied this criteria), ongoing improvement of oral skills (95%), parental motivation (77%) and absence of swallowing problems (72%).[3]

A child on EN may be considered for weaning when all four of these conditions are met:	
1.	Underlying disease is cured or stable
2.	Nutritional status is adequate
3.	Swallowing is functional and safe
4.	The family wishes to wean[4]

When should a patient be weaned?

Weaning should be initiated as soon as the indication for EN is no longer justified. Weaning should be considered from the point when EN is started.[4] Delaying weaning for a prolonged period can lead to increased resistance and anxiety from families.

How do you initiate weaning?

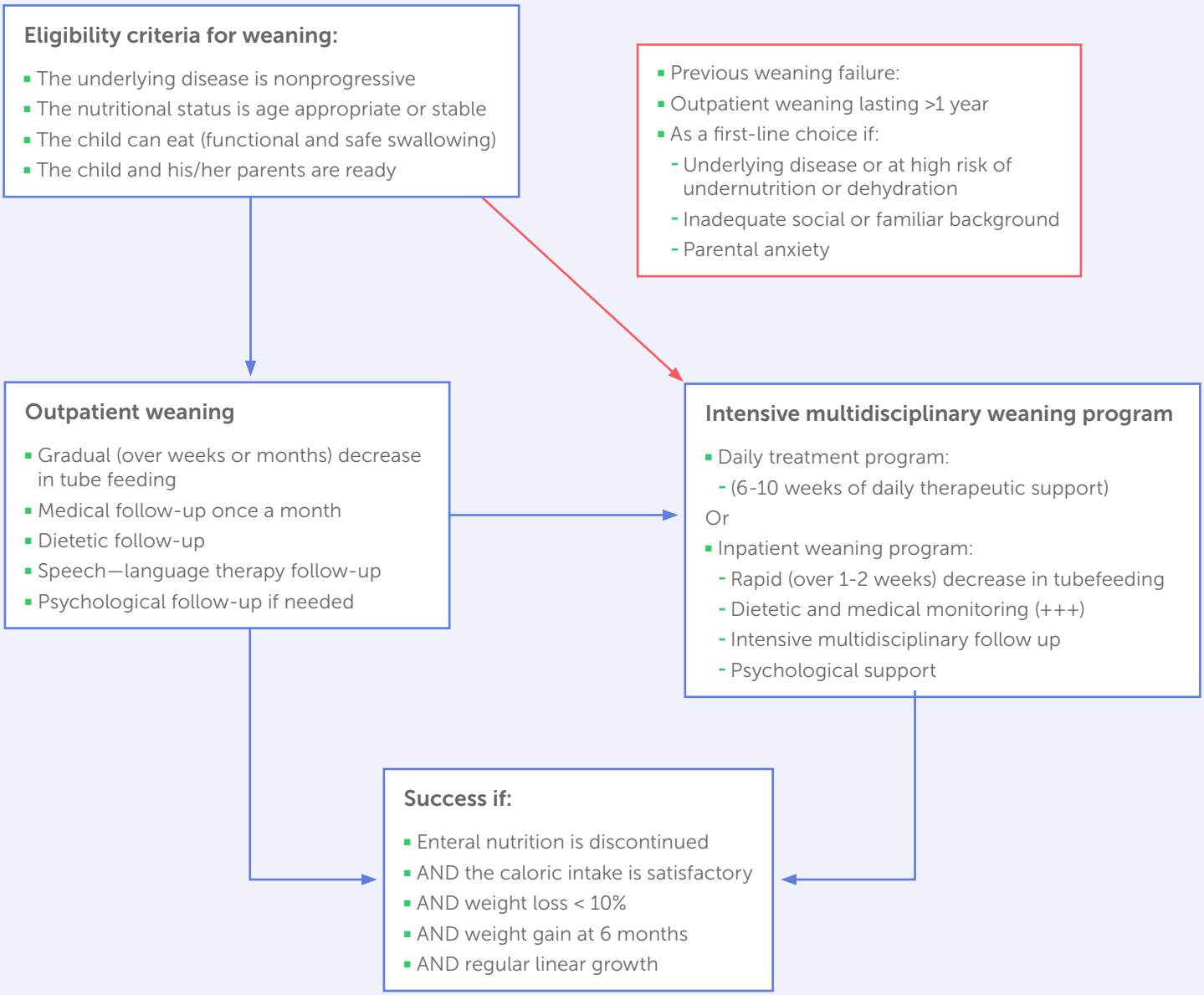
A multidisciplinary team is needed for weaning, and the first-choice setting is an outpatient clinic. Inpatient weaning or intensive day hospital weaning can be tried for children with underlying disease, high risk of undernutrition or dehydration, poor oral feeding skills, a challenging social/family background or strong parental anxiety.[4]

For inpatient weaning, patients should be discharged when weight is stable and oral intake accounts for at least 60% of total intake at admission, and the family is able to take responsibility for feeding. A transition plan should set out emergency strategies and outpatient follow-up.[4]

Common reasons for weaning failure include impaired oral feeding skills and patients needing psychological support.[5] Close monitoring of weight should be observed, with a maximum acceptable weight loss of 10%. Anthropometrics of weight and height should be monitored regularly for at least two years.

Micronutrient status should be assessed at 6 months after weaning then annually. The nasogastric tube should be removed as soon as oral intake accounts for 75% of daily needs. A gastrostomy tube should be removed after six months of definitive discontinuation of EN.[4]

Weaning is considered successful if EN is discontinued, satisfactory calorific intake is achieved, weight loss is <10%, there is weight gain at 6 months and regular linear growth.[4]



Can real food-based nutrition improve tolerance in children on enteral nutrition?

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There is increasing demand for real food-based EN. Parents perceive it to be more natural, healthier, better for the environment and more economical. Parents also value regaining control of their child's nutrition.

What does the evidence say about real food-based EN?

Real food-based EN has been a subject of growing interest in recent years. In a study published in 2015, half (50%) of adult patients on EN used blenderized tube feeding (BTF).[6] A 2017 questionnaire found that 89.6% of paediatric patients used BTF; 83% had BTF for >50% of food intake, 75% used a homemade preparation and 25% used a combined commercial and homemade preparation.[7]

A survey of 433 people using an online support group for parents of children on EN found that 50% used BTF; of these, 50% were using it without the support of a nutritionist.[8]

Parents and caregivers perceive food-based EN to be a more natural, healthy and environmentally friendly option that allows children to eat the same food as the rest of the family. Many caregivers also value being more in control of their child's diet.

A 2017 review found that blended food-based EN gave children better tolerance, improved gastrointestinal symptoms and helped with psychosocial aspects, but there were concerns about contamination.[9]

A blenderised diet has been found to increase microbiota diversity in oral and stool samples of pediatric G-tube fed patients, perhaps indicating the underlying mechanisms of improved tolerance.[10]

What are the advantages and disadvantages of real food-based EN?

Real food-based EN can be made from a commercial enteral formula prepared from real food or a homemade pureed food diet made from either baby food mixed with formula, or from everyday foods.

Feeds made of commercial baby food are easy to prepare, with lower risk of contamination and volume is easy to measure. A high-powered blender is not required and it can be used in a hospital or inpatient setting. The disadvantages are cost, limited selection and lower average caloric content.

In contrast, table foods may be more cost-effective, varied and allow children to eat the same food as their family. The disadvantages are a higher risk of contamination, more effort, and needing a high-powered blender and food scale.[11]

The Advantages and Disadvantages of real-food-based EN[12-21]

Advantages	
Gastrointestinal tolerance	▪ Decrease in: - Gagging and retching (including post-fundoplication) - Nausea and vomiting - Diarrhoea ▪ Constipation
Nutritional status	▪ Improved nutritional status ▪ More calories may be required to maintain/gain weight ▪ Can be tailored to individual needs, restrictions and preferences
Quality of life	▪ Improved comfort during feeds ▪ Better general health, fewer hospital admissions ▪ Parental autonomy over nutrition
Other	▪ Can be administered by mouth ▪ May help wean from EN ▪ Improves diversity of gut microbiota ▪ Lower cost to health system
Disadvantages	
Practical issues	▪ Time consuming ▪ Risk of error ▪ Clogging of tube ▪ Concerns about hygiene/ contamination/hanging time ▪ Requires nutritionist/dietician supervision ▪ Requires careful monitoring of growth and nutritional status ▪ Not suitable for acute setting (hospital)
Contraindications	▪ Patient aged <6 months ▪ Unstable patient ▪ Intensive care ▪ NG and NJ tube ▪ Gastrostomy <12 Fr ▪ Continuous feeds ▪ Lack of resources and equipment ▪ Parental inability to prepare feeds

How is real food-based EN used in a clinic?

A 2018 study followed 20 patients aged <16 years using a G-tube. The participants used BTF for six months. There was a marked decrease in incidence of vomiting, gagging, and requirement for antacids, and the percentage of patients with oral intake increased from 67% to 80%. Anthropometrics improved through the study.[22]

Patients required 50% more calories to maintain BMI. Micronutrient intake was the same or better compared to EN, with the exception of Vitamin D. Parents were positive about BTF: 94% said it was successful for their child and 100% would recommend it to other parents; 94% said their child appeared healthier and happier on BTF.[22]

Two thirds of parents (61%) said BTF was more time-consuming compared with preparing a regular meal. BTF increased faecal and oral bacterial diversity.[22]

Practical tips on feeding

Homemade formula is always more varied in composition than commercial formula. It can only be delivered by bolus, typically by syringe. A G-tube of at least 14 FR is necessary to avoid blockages.

The introduction of real food should be slow to allow the gut to adjust to the change in fiber content. One food should be introduced at a time to manage allergy risk, and growth should be monitored carefully.

Dieticians can provide parents with recipes to help meet caloric and micronutrient needs. Parents need guidance on portion size, measurement, cleaning and conservation, recipes and providing variety.[11]

With the active involvement of a nutritionist, real food can be a positive development for some children and their families. In particular, it gives parents the satisfaction of feeling they are in control of their child's nutrition. However, support and monitoring from a nutritionist is required to ensure it is done safely.

New trends in using a real food-based formula in various conditions: experience from clinical practice in the United Kingdom

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A national retrospective study in the UK looked at children who had switched to a real food-based formula. The majority of patients had a neuro-disability and were fed via gastrostomy. There was a 90% improvement reported in gastrointestinal symptoms. As a result of the findings, food-based formula is used more routinely in Great Ormond Street Hospital in intensive care and oncology.[23]

A follow-up study sought to investigate what was happening at an intestinal microbiome level to make food-based formulas better tolerated.

Paediatric intensive care and sepsis

Sepsis is the leading cause of mortality in hospitalised children. Antibiotic use of sepsis can increase the susceptibility to other opportunistic infections due to intestinal dysbiosis. Intestinal dysbiosis can also cause antibiotic-associated diarrhoea. In tube-fed children, frequency of diarrhoea ranges from 29-72%.[24]

Within the microbiome, fibre and prebiotics feed bacteria (*Lactobacillus, Bifido-bacterium*). Short-chain fatty acids (butyrate, acetate, propionate) are a by-product of this metabolic process, which assist intestinal integrity by providing fuel for enterocytes and they also have an anti-inflammatory effect in the mucosa and at a systemic level.

When children are in intensive care, antibiotics interrupt the normal functioning of the gut and production of short-chain fatty acids is reduced, meaning the gut no longer benefits from the protective mechanism. It might be possible that use of a food-based formula (Compleat Paediatric) in a clinical setting could mitigate some of this effect.

The study

The pilot, prospective observational study looked at children aged 1-16 who were admitted to a paediatric intensive care unit (PICU) with sepsis requiring mechanical ventilation and exclusive enteral nutrition. Participants also needed to have received antibiotics for sepsis management and developed diarrhoea.

Data collected included the type and duration of antibiotics, C-reactive protein (CRP) and lactate levels, anthropometry, stool frequency and consistency, and stools were collected for mass spectrometry to detect short-chain fatty acids.[25]

Patients were switched to Compleat Paediatric when they showed feed intolerance after admission to PICU with sepsis. Stools were collected at baseline and weeks one and two. The mean age of patients was 10, and the most common underlying cause of infection was respiratory tract infection.

Study findings

Stool frequency reduced from 2.6 to 1.2 and consistency 6.6 to 3.6 at one week. As CRP levels remained high, this change could not be attributed to improvement in sepsis alone. In addition, intestinal dysbiosis after a week

of antibiotics would be likely to produce a worsening of symptoms rather than improvement.

In view of this, it was concluded that the feed change was producing the improvement, and this change could be observed within 48 hours of introducing the food-based formula.

Analysis of faecal short-chain fatty acids saw a reduction in acetate in the first week but relatively stable levels of propionate and butyrate. It may be that the antibiotic used targeted the microbiomes that produced acetate.

The study indicated that a food-based formula was well tolerated by paediatric sepsis patients with antibiotic-related dysbiosis receiving enteral nutrition. Stool consistency and frequency was improved within one week of switching to food-based formula. Children maintained faecal butyrate and propionate concentrations.

Results: longitudinal faecal short chain fatty acids concentrations (umol/g)

Short chain fatty acid	Baseline N=20	Week 1 N=20	Baseline and week 1 Z Value (p-value)	Week 2 N=12	Baseline and week 2 Z Value (p-value)
Acetate, mean (±SD)	2.1 (2.0)	0.9 (0.7)	-1.01 (0.3)	0.7 (0.5)	-1.75 (0.7)
Propionate, mean (±SD)	0.5 (0.4)	0.8 (0.4)	-1.95 (0.2)	0.5 (0.3)	-0.29 (0.4)
Butyrate, mean (±SD)	0.3 (0.2)	0.3 (0.2)	-0.33 (0.8)	0.2 (0.1)	-0.20 (0.2)
Total	**2.9 (2.0)**	**2.0 (1.0)**	**-0.42 (0.7)**	**1.3 (0.8)**	**-1.30 (0.09)**

Wilcoxon Signed-Rank tests, presented as Z statistics.

Quotes

"We have this huge increase in people on blended foods, which we can't implement in intensive care due to restrictions – so this formula is a great compromise."

Dr. Graeme O'Connor

"Commercial formula is easier to use when travelling, some families use homemade blend at home and commercial formula when away from home."

Prof. Valérie Marchand

"There's a global shift towards a more wholesome, more plant-based diet – it's what parents want. Industry is responding to what's happening in the world."

Dr. Graeme O'Connor

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